Nuclear and Radiochemistry

Program Description

This project continues an introductory undergraduate/graduate-level course, which is focused exclusively on nuclear and radiochemisty. The program, which is fully accredited by the University of New Mexico (UNM), features both a lecture course and selective research fellowships, and is coordinated through the Seaborg Institute for Transactinium Science (ITS). The lecture course was presented during the spring and summer semesters at UNM-Los Alamos (UNM-LA). The lectures provide an introduction to nuclear and radiochemistry, areas in which most university facilities lack the expertise. The 12-week summer research fellowships entailed participation in both the lecture course and an independent research project.

Performance Objectives and Milestones

The objective for designing and offering this course is to continue development of an internationally recognized and greatly needed educational program which will (1) serve as a national resource for the teaching of nuclear sciences, (2) provide a vehicle for early recruitment of the next generation of nuclear scientists and engineers, (3) offer accredited courses which can expedite a student's graduation, (4) increase the Laboratory's staff involvement in nuclear science outreach activities, and (5) provide a mechanism for the career development of the Laboratory's, DOE's and the National Nuclear Security Administration's (NNSA's) staff and technicians. We are hopeful that this program will continue to grow in subsequent years and lead to the establishment of a number of similar educational curricula in related disciplines, e.g., nuclear materials science and environmental science. At the conclusion of the course the students acquired a greater appreciation of the diverse use of the principles of nuclear and radiochemistry in nuclear energy, national defense activities, and legacy cleanup. With this insight, together with the introduction to the extensive research facilities available at national laboratories, we hope these talented young researchers will be stimulated toward a career in nuclear and weapon-based science. All previous milestones listed in our proposals including Fellows search, presenting the course, and research presentations were realized, and we are continuing this trend in the current fiscal year. In addition, we are continuing to expand and adapt the program to access larger groups of students, staff, and technicians.

Highlights of Year's Accomplishments

We detail below our progress for the 2001 fiscal year on three separate projects: (1) the lecture course at the Laboratory; (2) sponsoring of research fellows in nuclear and radiochemistry science during the summer of 2001; and (3) increasing outreach activities for Laboratory staff. It should be noted that a majority of our activities occurred during the summer, leaving the first half of the year for planning and development. In general support of educational efforts in nuclear science, the Laboratory has established and funded a new position within the Seaborg Institute, Associate Director for Education. Dr. D. Webster Keogh has accepted the position.

(1) Dr. Moses Attrep taught the "Nuclear and Radiochemistry" course at UNM-LA twice in this last fiscal year, one each in the spring and summer semesters. There were a total of 26 people enrolled at UNM-LA: students, technicians, and staff members from the Security, Chemistry and Nuclear Materials Technology Divisions in the Laboratory. In addition, four

students from the Waste Isolation Pilot Plant (WIPP) were enrolled in the course and used distance-learning technology to take the class. The collaboration with the broadcasting personnel at the Waste-management Education and Research Consortium (WERC) site at New Mexico State University continued this year, where a re-broadcast of the signal via satellite was sent to downlink sites around the country.

(2) In December 2000, we distributed posters to approximately 125 chemistry departments nationwide announcing our intention to fund six Seaborg Institute Research Fellows during the summer of 2001. We also have updated and maintained our Website (http://pearl1.lanl.gov/seaborg) to provide information about the Seaborg Institute and its educational programs as well as to allow fellowship applicants to apply online. The deadline for applications was March 1st. The selected candidates were composed of two senior undergraduates (from the University of Wyoming and Texas Tech University), and two graduate students (from the University of Missouri and the University of Chicago). The Fellows were at the Laboratory for 10–12 weeks, starting in June 2001. They attended the "Nuclear and Radiochemistry" course in addition to performing independent research under the guidance of the Laboratory scientists. During their summer research, they gave oral presentations of their work at weekly meetings to groups of staff, postdocs, and fellow students. Tours and demonstrations were also organized this year of TA-55, the plutonium processing facility, and a destruct shot (500-pound explosive test).

(3) In March 2001, we purchased satellite time for the months of June and July 2001. This purchase provided our programs access to the same satellite 24 hours a day seven days a week during the prescribed months. This access enhanced our ability to reach other universities, DOE, and NNSA sites by simplifying the receipt of our broadcasts to a single satellite position. Within these complexes, a variety of people exist with differing time constraints as well as educational backgrounds and needs. In order to accommodate these people, we tested the use of this satellite time for the sponsoring of future short courses, workshops and seminar series in nuclear and weapons-related sciences. The different educational approaches are designed to target the various audiences, maximizing information exchange while minimizing time requirements. In order to promote the program Dr. Attrep visited the WIPP site on February 22–23, 2001. Contacts were also made with Lawrence Livermore National Laboratory, Clemson University, the University of Missouri, MIT, and Florida State University.

In order to continually improve the quality of the program, feedback from both UNM course surveys and custom-made course evaluations was employed. These surveys seek input on the specific course topics, potential interest in additional classes in future years, the attitudes of the students toward actinide chemistry, and the possibility of future career plans within actinide or nuclear science. In addition, we are compiling complete listings of e-mail addresses of all students participating in the courses in order to track the future educational or employment endeavors of the students. This has enabled us to judge the potency this program has in stimulating interest among young scientists in the "nuclear future."

The Laboratory and NNSA Defense Programs have a mission in nuclear weapons to ensure confidence in the safety, reliability and performance of US nuclear weapons without nuclear testing. In the absence of nuclear testing, this requires a science-based approach to stockpile stewardship supported by a broad range of science and technology capabilities. Decisions must be made based on sound technical understanding and expert judgment developed through theory, experiment, and simulation. It is abundantly clear that our understanding of the science of nuclear weapons and the effects of aging and manufacturing must be preserved. Therefore, one of the principal long-term issues facing the DP

laboratories is that of maintaining the quality of our scientific and engineering staff. Of grave concern is that a large fraction of the Laboratory staff could retire within the next decade (42% of LANL technical staff are aged 50 or older), and their expertise and knowledge must be transferred to a new generation. From this perspective, nuclear and radiochemistry is a crucial component of the science and technology needed to reconstitute an underground nuclear testing or nuclear weapons production capability if the Laboratory is called upon to do so by national security requirements. It is sobering to recognize that virtually all of the Los Alamos students and new hires over the past 10–20 years lack formal training in both modern *f*-element chemistry and nuclear and radiochemistry, and most of what they have learned has been through informal mentoring or by hands-on experience. Surely, other DP laboratories are facing a similar situation, and we are exploring ways to work with them. Our educational program is designed to provide overlap to transfer this corporate knowledge in a formal classroom setting and build a scientific base for future programmatic success. On page 29 of the Chiles Commission Report "Maintaining United States Nuclear Weapons Expertise," it is stated that "Post-doctoral, intern, and continuing education programs should be emphasized as especially important recruitment tools, and special emphasis should be placed on making the nuclear weapons complex an attractive place for women to work, given the increasing fraction of women in the scientific and engineering programs at American universities." A combined total of 115 students have registered for our workshops and summer course. In addition to the students enrolled at UNM-LA, local Albuquerque and distance-education sites coordinated through either the UNM or WERC systems led to the registration of students from UNM's Albuquerque campus, New Mexico Tech in Socorro, and the Carlsbad Field Office. This course attracts a diverse audience representing a number of ethnic and minority groups.

Technician and Student Development
We will continue distributing announcements for courses and workshops to the students, postdocs, and technicians who work within the Chemistry, Nuclear Materials Technology, Materials Science Technology, and Explosives Divisions at the Laboratory. The course announcements this year were posted on both the student and postdoc pages on the Laboratory's Website so that it was seen by all of the incoming students this summer. We have previously had extremely positive responses to the courses from many Laboratory employees, and a significant number registered to take the course.

The four Research Fellows, who joined the Laboratory this fiscal year, were

Student: Thomas Marrero, graduate student, University of Missouri-Columbia
Mentors: Drs. Moses Attrep and Norman Schroeder, Chemistry Division (C-INC)

The purpose of Tom's work was to determine the optimum conditions for the removal of radioiodine from simulant dissolver solutions. Iodine-129 is of particular interest because of the unfavorable risk assessments for storage. The collected 129I will be collected and converted to the chemical form where it will be transmuted from 129I to 130Xe by neutron capture in a high-flux neutron source.

Tom investigated iodine chemistry in aqueous solutions and chemical capture methods for fission-produced iodine at nuclear waste treatment facilities. An equilibrium-based model to predict the iodine chemistry includes the various forms of iodine compounds, I2, I-, IO3-, etc., and the effects of ionic strength, nitric acid concentration, temperature, and nitrogen gas flow that remove iodine from aqueous solutions. Bench-scale experiments set the parameters for removing the iodine under the shortest time with the simulant used.

Student: Arif Ali, Pritzker graduate student, University of Chicago
Mentor: Dr. Steve Son, High Explosives Science and Technology Group (DX-2)

Arif worked on numerous projects at the Laboratory. One of the projects that was brought to completion involved the investigation of the ignition properties of various high explosives. In order to accomplish this goal, a CO_2 laser was used to thermally excite the high explosive, and a number of diagnostic instruments were used to study the phenomenon. Of particular note was the use of second harmonic generations to investigate various aspects of the ignition process.

A second project on which Arif has worked was the design of a new rocket thrust stand. The purpose for this stand was to test advanced, low-signature propellants being developed within the Laboratory. A majority of this summer's work focused on measuring the pressure dependence on the deflagration rates of high explosives.

Student: Sarah Turner, undergraduate student, University of Wyoming
Mentor: Dr. Robert L. Bishop, High Explosives Science and Technology Group (DX-2)

Sarah worked within the High Explosives Science and Technology group (DX-2). Her research project centered around the chemical properties of a variety of high explosives. Similar work in that area, that has been previously done, includes the chemical destruction of high explosives using base hydrolysis.

Student: Bryan Bockmon, undergraduate student, Texas Tech University
Mentors: Dr. Steve Son, High Explosives Science and Technology Group (DX-2) and Prof. Michelle Pantoya (Texas Tech University)

Bryan had the good fortune of being involved with a collaborative project between his research advisor at Texas Tech and a technical staff member from the Laboratory. At Texas Tech, Bryan had conducted flow-visualization research. The underwater flow-visualization experiments consisted of gathering video data of flow patterns across a plain cylinder under specific conditions. Bryan used this background at the Laboratory by filming and analyzing a number of explosive test shots. The equipment used was highly specialized and has provided a basic understanding of shock wave evolution.

Bryan also helped in the development of a system to study the progression of burning explosives. This project consisted of designing and constructing a reaction chamber to gather combustion data on new pyrotechnic and explosive materials. He spent a good part of this summer running experiments in this chamber and analyzing the gas products.

Future Plans

Staff Development

As indicated in the demographics of all of the Defense Programs' laboratories, the work force is aging significantly. The effect of this aging work force has now directly impacted this program. One of the professors, Dr. Thompson, has retired from the Laboratory and was not be able to teach the class in the summer. As a result Dr. Attrep will be mentoring a new staff member to co-teach the course.

Short Course, Workshop, and Seminar Series

As mentioned above, satellite broadcasting of short courses, workshops and seminar series were tested during the months of June and July 2001. Due to the positive results of these tests, new educational programs will be run as frequently as possible with an initial target of one per month. The current topics under consideration for these presentations are statistics, radionuclides in the environment, and nuclear and radiochemistry.

Summary

We have described the activities, which have taken place in FY01 for this program as well as comprehensive data encompassing the first two years. Our intention is to expand the scope of the program to the point at which students will be able to take fully-accredited courses not only in nuclear and radiochemistry, but also in closely allied subjects such as statistics and environmental chemistry.

Institutions represented by students participating in Nuclear Science Education for the21st Century: Nuclear and Radiochemistry.

University of New Mexico
New Mexico State University
University of Chicago
University of Missouri
University of Wyoming
Texas Tech University
Waste Isolation Pilot Plant